

Abstract

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FRICION STIR WELDING

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Friction stir welding (FSW) is a solid state welding process invented in 1991 at The Welding Institute in the United Kingdom. A weld is made in the FSW process by translating a rotating pin along a weld seam so as to stir the sides of the seam together. FSW avoids deleterious effects inherent in melting and promises to be an important welding process for any industries where welds of optimal quality are demanded. This article provides an introduction to the FSW process. The chief concern is the physical effect of the tool on the weld metal: how weld seam bonding takes place, what kind of weld structure is generated, potential problems, possible defects for example, and implications for process parameters and tool design. Weld properties are determined by structure, and the structure of friction stir welds is determined by the weld metal flow field in the vicinity of the weld tool. Metal flow in the vicinity of the weld tool is explained through a simple kinematic flow model that decomposes the flow field into three basic component flows: a uniform translation, a rotating solid cylinder, and a ring vortex encircling the tool. The flow components, superposed to construct the flow model, can be related to particular aspects of weld process parameters and tool design; they provide a bridge to an understanding of a complex-at-first-glance weld structure. Torques and forces are also discussed. Some simple mathematical models of structural aspects, torques, and forces are included.